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EVALUATION'OF "QUALITY" ANADROMOUS SMOLT PRODUCTION TECHNIQUES

Period Covered: 1 October 1977 to 30 September 1978

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EVALUATION OF "QUALITY" ANADROMOUS SMOLT PRODUCTION TECHNIQUES

ABSTRACT

Rearing comparison of Skamania vs. Dworshak steelhead stocks showed similar final size but differing behavior. Dworshak stock steelhead displayed higher sensitivity to stress from factors such as disease, feed size changes and handling than did Skamania stock steelhead. This resulted in greater numbers of stunted fish (pinheads) in the Dworshak stock population at the end of the raceway rearing phase.

In-pond growth patterns showed Skamania fish displaying a larger length increase per month early in the pond rearing phase with Dworshak stock growing fastest at the end of that cycle. Samples taken upon release disclosed both groups similar in size but with fewer sub-smolts in the Dworshak population versus the Skamania population.

The initial phase of the mixed species sympatric rearing experiment shows recognizable spatial segretation between the salmon and steelhead in the pond. The steelhead show faster growth than the salmon and a definite dominance over the chinook during feed acquisition. The control pond of chinook salmon are presently larger than the salmon in the mixed pond.

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RECOMMENDATIONS

We recommend that future anadromous fish rearing efforts at the Hayden Creek Research Station be directed toward spring chinook salmon exclusively.

We recommend that downriver steelhead stocks (such as Skamania stock) not be considered for replacement or enhancement of indigenous Idaho steelhead stocks.

OBJECTIVES

To investigate and explore various methods and techniques of rearing chinook salmon and steelhead trout to the smolt stage in dirt bottomed ponds.

To determine those rearing and handling procedures that maximize the quality and quantity of smolts and promote maximum smolt survival and adult contributions and returns.

To compare the rearing-growth-survival of various stocks of anadromous fish reared under identical conditions at the Hayden Creek Research Station.

To explore the effects of simultaneous mixed species pond rearing of spring chinook salmon and summer steelhead trout.

TECHNIQUES USED

Genetic Stock Comparison - Skamania vs. Dworshak Stocks

Incubation

On 22 March 1977, we transported 263,000 Skamania-stock eggs from the Washington Department of Game's Vancouver Hatchery, where they had been eyed, to the Hayden Creek Research Station. These eggs were taken from adults which returned to the Skamania Trout Hatchery near Washougal, Washington. The selective spawning of early ripening adults at this station advanced the-time of ripening to December and January for this stock of summer steelhead.

We incubated these eggs in Heath stack incubators using straight Hayden Creek water at 4.3-6.1 C (40-43 F) to slow development until a nearly equal number of Dworshak-stock eggs could be obtained and hatched. The Skamania eggs completed hatching on 15 April 1977.

We received 259,000 eyed Dworshak-stock eggs on 4 May 1977 and incubated them in straight spring water at 12.7 C (55 F) to speed development. This allowed the two groups to be moved to the raceways about the same time, and at the approximate same size and stage of development. Hatching was complete on 23 May 1977.

Raceway Rearing

On 16 May 1977, we moved 257,000 Skamania-stock, button-up fry to the south raceway. We transferred 257,000 Dworshak-stock fry to the north raceway

on 1 June 1977. Both raceways measure 61 x 1.2 x 1.2 m (200 x 4 x 4 ft) and receive straight spring water at 12.7 C (55 F). We hand fed Oregon Moist Pellets (OMP) hourly to both groups of fish through the starter mash size of feed. Dry diet of appropriate size replaced the OMP in late June when the fish averaged about 1,000 kg (455/lb).

We sampled the raceways weekly and recorded growth rates. Mortality was monitored by direct count of the dead fish removed from the tail screens and averaged about 1% per month.

Hayden Creek water was added to both raceways as needed to maintain adequate dissolved oxygen. We treated for bacterial gill disease with Purina 4X (2 ppm - 3 days consecutively) for Costia with formalin (1:6,000 – 1-hr flush).

We moved 126,000 Skamania-stock fingerlings from the north raceway to the north pond on 29 September 1977. These fish averaged 83.0 mm (3.3 in) and 163.8/kg (74.5/ib). On 24-25 October 1977, we moved 128,000 Dworshak fingerlings to the south pond. Prior to ponding we graded out the smallest fish to compensate for a period of decreased growth. We contribute this lack of growth primarily to feeding oversized feed received from the contracted supplier. The Dworshak fingerlings average 84.8 mm (3.3 in) and 195.8/kg (89.0/lb) at ponding.

The 112,000 Skamania-stock fingerlings excess to our research needs were planted in the upper Lemhi River on 12 August and 29 September 1977. Nearly 80,000 Dworshak-stock fingerlings were planted in the upper East Fork of the Salmon River on 28 October 1977.

Pond Rearing

Rearing continued for the two groups in the two .2 ha (.6 acre) dirt ponds under equivalent conditions. Both ponds received straight spring water (12.7 C). Dry feed of appropriate size was dispensed by Nielsen automatic feeders to both ponds hourly from dawn to dusk. We administered a medicated feed treatment (Terramycin at 6% TM50 for 12 days) to both groups of steelhead although the symptoms of bacterial infection occurred only among the Skamania-stock fish. Hayden Creek water added to the ponds' inflows increased dissolved oxygen to acceptable levels until release. Monthly samples were taken to monitor growth and mortality was estimated at 1% per month.

Sampling Method

Monthly pond samples were obtained by baiting the fish over an umbrella net measuring 2 x 2 m (6 x 6 ft) with dry feed. Approximately 300 fish were weighed on a 27 kg (60-lb) dairy scale before being anethetized with MS-222 and measured in 10 mm (0.4 in) increments, i.e. a fish measuring 70-79 mm was recorded as 75 mm. Mean length was calculated from this information. Fish weight obtained from the sample group was expressed in fish per kg.

Release

Release of the fish was accomplished by draining the water from the ponds through a valved pipe at the lower end of each pond. A screened box at the

exit end of the pipe functioned as a trap that was opened or closed to retain smolts for sampling. Emigration was voluntary from this point.

Sympatric Rearing - Summer Steelhead vs. Spring Chinook Salmon

Incubation

On 4 October 1977 we received 288,000 eyed spring chinook eggs from the Rapid River Hatchery near Riggins, Idaho. These eggs transported well in Heath-Techna egg shpping cartons. We loaded the eggs into Heath stack-type incubators at 37 cm' (40 oz) per tray and adjusted the flow to 19 1pm (5 gpm) of Hayden Creek water at 1-9 C (34-48 F). Hatching was completed in early November. Button-up occurred in late March.

We took receipt of 110,000 eyed Skamania-stock summer steelhead eggs on 16 February 1978. We transported the eggs in Heath-Techna egg shipping cartons. The top trays were loaded with ice at 1400 hr at the Vancouver Hatchery and this held the eggs in excellent condition until arrival at the Hayden Creek station at 1900 hr the following day. We loaded the incubators at 30 cm^3 (32 oz) per tray and adjusted the inflow to 10 C (50 F) at a rate of 19 1pm. Hatching was completed in early March. Button-up occurred at the end of March.

Raceway Rearing

We transferred 104,000 button-up Skamania-stock steelhead fry to the north raceway on 28 March 1978. A Hayden Creek-spring water mix, 12 C (53.6 F), was used for rearing. We moved 217,000 Rapid River-stock spring chinook *fry* to the south raceway on 30 March 1978. These fry also received a spring water mix at 12 C.

Oregon Moist Pellets (OMP) of starter mash size, then 1/32" pellets were hand fed hourly to both groups of fish. Moore-Clark dry diet replaced the OMP in mid-May when the fish averaged about 1,000/kg (455/lb). By varying the proportion of the cooler Hayden Creek water during this rearing phase, we were able to equalize the size of the two groups prior to ponding. We treated both raceways for bacterial gill disease with Purina 4X at 2 ppm and for Costia with formalin at 1:7,000. A medicated feed treatment (Terramycin for 12 days) was administered to both groups of fish to combat a systemic bacterial infection.

Pond Rearing

The core of this sympatric rearing investigation lies in the pond rearing phase. We transferred 66,000 Rapid River-stock spring chinook from the south raceway to the south pond on 20 July 1978. We moved 64,000 Skamania-stock summer steelhead from the north raceway also to the south pond on 21 July 1978. Transfer was accomplished by weighing the fish in 19-1 (5-gal) buckets suspended from a 27 kg (60-lb) dairy scale and pouring them into a hopper/pipe assembly which emptied into the south pond. Frequent samples of fish/kg and length allowed close monitoring of numbers moved and fish size (Table 1). Final pond loading resulted in nearly equal numbers of both species and at near equal size. Slightly more chinook salmon were released into the pond to compensate for the number of "pinheads" identified during sampling. We feel that these stunted fish

will not survive until release in April 1979 (Fig. 1).

We tranferred 129,000 Rapid River-stock spring chinook from the south raceway to the north pond on 24 July 1978. These fish will be used as a control group to compare with the sympatric group in the south pond. We used the same methods of enumeration and transfer except we transported these fish in a 757 1 (200 gal) fish tank which replaced the hopper/pipe assembly. Numbers of fish were slightly increased in this group also to compensate for the number of pinheads.

Table 1. Numbers and measurements of fingerling salmon and steelhead placed in the ponds for mixed species rearing.

	Chinook South Pond	Steelhead North Pond	Chinook North Pond
Fish/kg (Fish/lb)	208.1 (94.6)	206.4 (93.8)	226.2 (102.8)
Length mm (in)	77.0 f.l. (3.0)	80.5 t.l. (3.2)	74.7 f.l. (2.9)
Total kilograms (lbs)	1534.9 (697.7)	1498.6 (681.2)	2760.1 (1254.6)
Total fish	66,002	63,897	128,973
Pinheads (%)	6534 (9.9)	4153 (6.5)	11,445 (11.2)
Non-pinheads	59,468	59,744	117,528

Pond rearing continued for the sympatric group (south pond) and for the allopatric group (north pond) under equivalent conditions. Both .2 hectare (.6 acre) dirt ponds received straight spring water 12.7 C (55 F). Moore-Clark and Rangen dry feeds were dispensed every second hour from dawn to dusk by Nielsen automatic feeders. Seven feeders are located on the perimeter of the north pond and eight on the south pond.

Sampling Methods

We sampled both species weekly during raceway rearing using a standardized displacement method. Fish weight was calculated by the amount of water displaced assuming the fish had a specific gravity of 1.0 equalling that of the water. We recorded the information graphically to allow continuous comparison of growth rates.

Samples were taken twice a month during pond rearing. We captured the fish by baiting them over a 2 x 2 m (6 x 6 ft) umbrella net using dry feed as bait. Approximately 300 fish were weighed in on 27 kg (60 lb) dairy scale before being anethetized with MS-222 (Tricaine Methane Sulfonate). Total length was measured and recorded in 10 mm (3.9 in) increments, i.e. a fish measuring 70-79 mm was recorded as 75 mm. Mean length was calculated from this data. Fish weight obtained from the same sample group was expressed in fish per kg.

Observation Methods

To document interaction and behavior of the two species during pond rearing

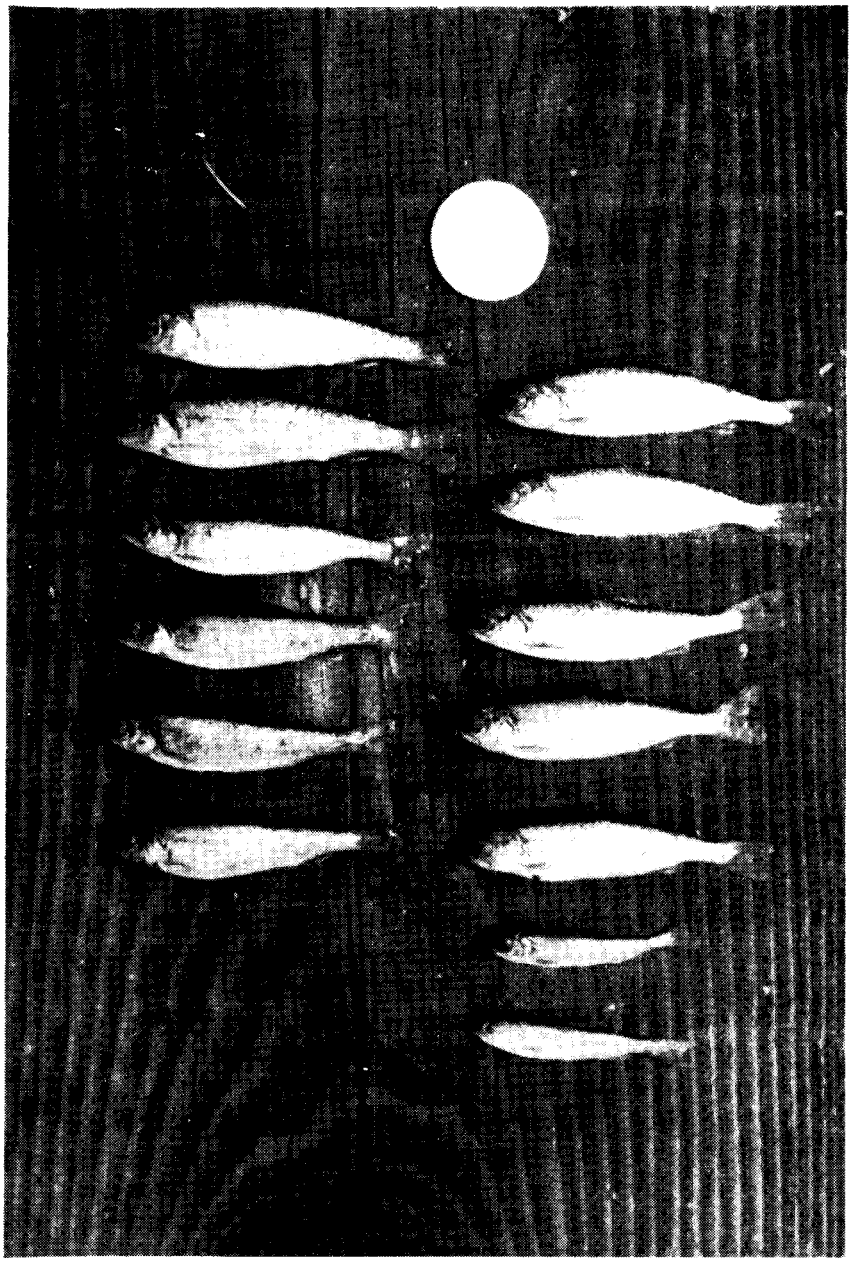

Figure 1. The juvenile steelhead (left) and salmon were approximately the same size when placed in the pond in July, 1978. Stunted fish, "pinheads", were not included in the final pond transfer counts.

we employed three main observation techniques: in-pond, bank and sampling observations. For in-pond observations we entered the pond with mask, snorkel and wet suit. Observations were recorded on a water card before transcription to a log book. Photographs depicting distribution and segregation were taken using an underwater camera. Typically we entered the pond at the inlet and floated slowly around the perimeter of the pond, also surveying the mid-pond areas. In-pond observations included non-feeding and feeding periods, sunny and overcast days, and morning and afternoon observation times. Upon leaving the pond, all observations were entered in a log book.

Bank observations were made along the pond edges and from the feeder platforms. Observations included numbers and species using the shallow waters and aquatic vegetation for rearing, amount and distribution of surface feeding on insects, and feeding activity during feed delivery.

Sampling observations allowed us to monitor growth rates. We also estimated relative abundance around the feeders during feeding periods. We observed changes in species distribution in the capture net as a function of time after feed was delivered. Condition was also noted during sampling. Stomach contents from some of the sampled fish were analyzed to check for cannabalism. Of 142 stomachs inspected to date, none contained remains of fish.

FINDINGS

Genetic Stock Comparison - Skamania vs. Dworshak Stocks

Incubation

The incubation phase of this comparative rearing investigation indicated slightly better survival for the Dworshak eggs (99.2%) than for the Skamania eggs (97.7%) from the time of loading into the incubators until button-up. However, initial incubation water came from different sources and could account for this difference in survival.

Raceway Rearing

In comparing raceway rearing we concerned ourselves mainly with growth and survival. Weekly samples, using a standardized displacement method, showed similar growth rates up to the time we ponded the Skamania fish (Fig. 2). At this time, the recently ponded Skamania fish grew well while the Dworshak fish experienced a 3-week period of slowed growth. We partly attribute this lack of growth to our feeding oversized feed, but we feel these two genetic stocks reacted differently to the raceway rearing regime also.

The major difference between stocks was mortality. Observed mortality for the first 3 months of raceway rearing was higher for the Skamania fish (4.3%) than the Dworshak fish (2.2%), but during this period we noted a "disappearance" of a large number of Dworshak fish. We eventually confirmed a 36,000 fish debit that could not be accounted for by observed mortality or escape. We have seen this inventory loss occur in past years with Dworshak-stock fish but it occurred during pond rearing. This has not been noticed with Skamania-stock steelhead. Overall survival during the raceway phase of rearing was 92.9% for the Skamania-stock fish and 80.8% for the Dworshak group.

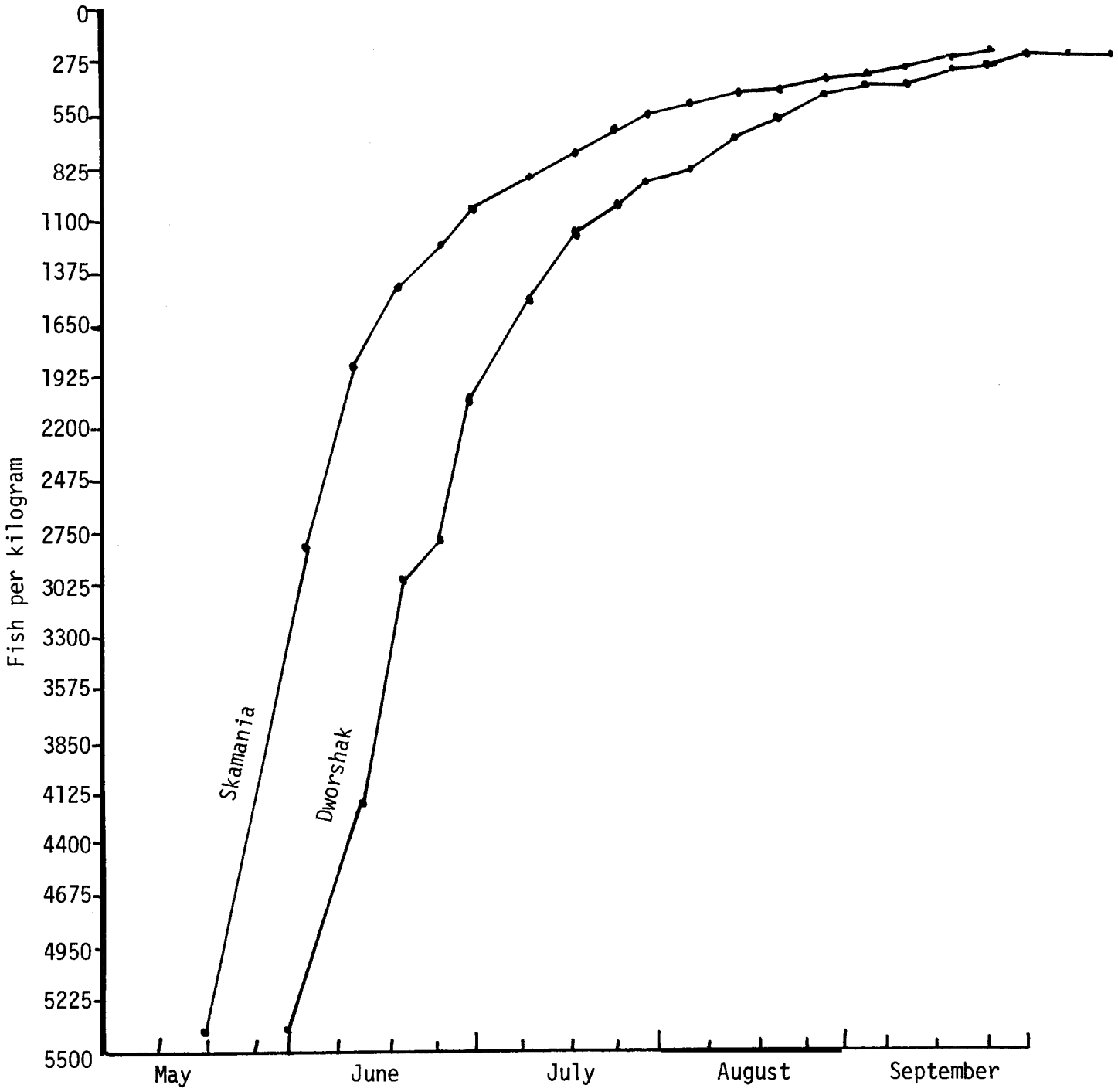

Figure 2. Weekly samples showed similar growth rates for Skamania and Dworshak stock of steelhead during raceway rearing.

The Dworshak fish appeared more affected by changes in rearing conditions than the Skamania fish. The Dworshak fish were slower in starting to feed when moved from the incubators. Some of these fish refused the larger size feed when routine feed size changes occurred. When bacterial gill disease caused both groups to decrease feeding, a portion of the Dworshak fish failed to resume normal feeding activity after the disease was controlled. All of these rearing characteristics decreased the overall quality of the Dworshak group by increasing the number of pinheads.

Pond Rearing

The two groups of summer steelhead behaved similarly during pond rearing. Length increase was 86.1 mm (3.4 in) for both groups but the Dworshak fish were ponded 1 month later. The percent of length increase per month was greater during the earlier months of pond rearing for the Skamania group, but greater during the final 2 months for the Dworshak group (Table 2).

Survival was equal for both groups with an estimated 1% mortality per month. Disease problems were equal for both groups requiring one medicated feed treatment during the 8-month pond rearing period.

Table 2. Percent of growth per month for two stocks of steelhead during the pond rearing phase at Hayden Creek, 1977-78.

Month	North pond growth (mm) Skamania	South pond % growth (mm) Dworshak
September		
October	19.4	
November	23.5	19.6
December	11.3	21.4
January	16.7	11.9
February	13.7	9.7
March	12.0	16.5
Release	3.4	20.8

Release

Skamania Stock

We released 117,500 Skamania-stock summer steelhead from the north pond directly into Hayden Creek on 20 April 1978. Samples of 1,146 fish taken during the early, middle and late portions of the release showed an average length of 164.6 mm (6.5 in) and an average weight of 21.45/kg (9.75/lb) (Fig. 3). We observed a wide range of length distribution and a large number of sub-smolts (47.2%). We had not seen these sub-smolts in previous monthly samples. This pond contained many good quality smolts and fish as small as 150 mm (5.9 in) showed the physical characteristics of smolted fish. Seaward emigration was good as evidenced by few fish remaining near the release point 4 days after release. Very little dorsal deformity occurred in this group of fish.

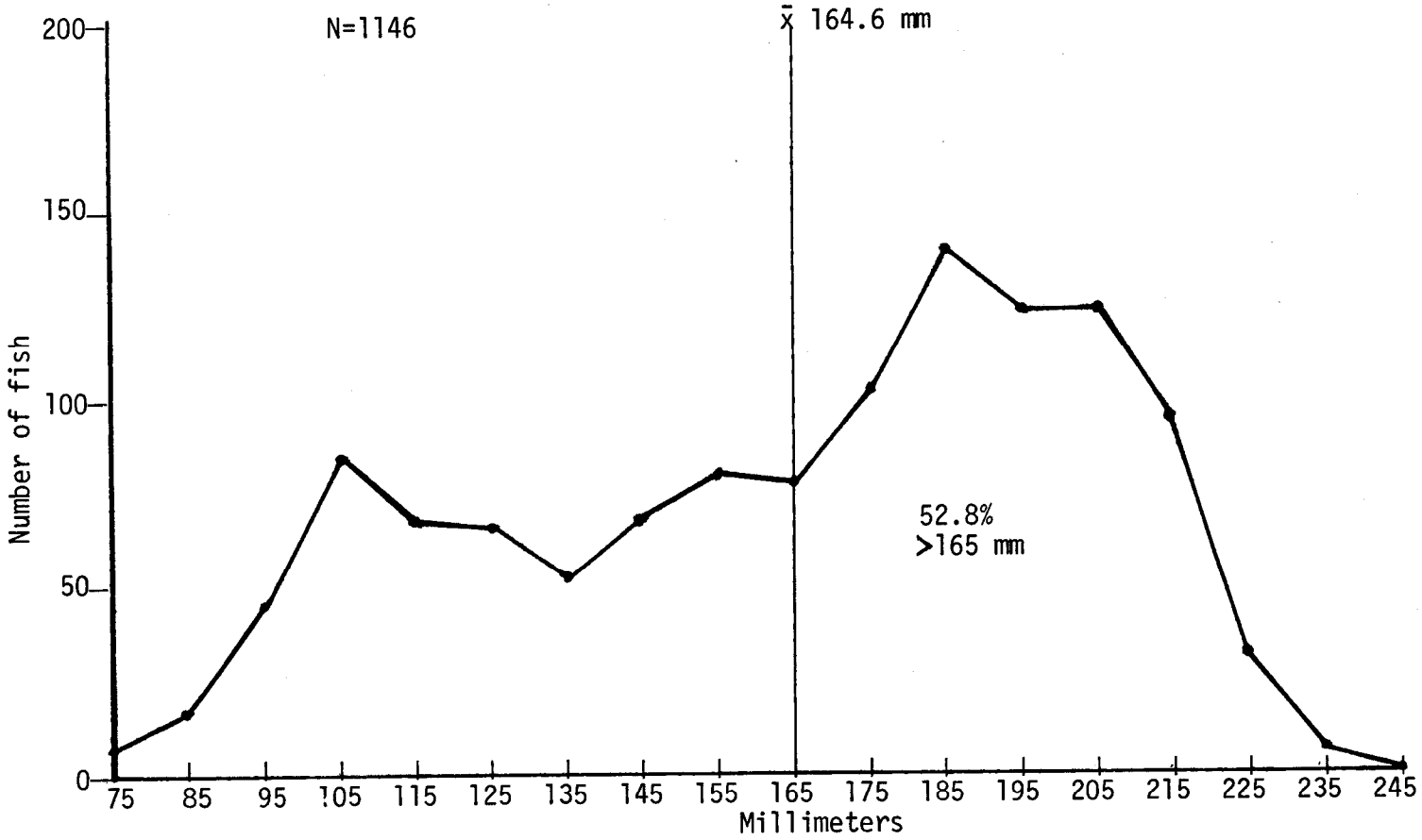

Figure 3. Length frequency of Skamania stock steelhead trout released from the Hayden Creek north pond, 20 April 1978.

Dworshak Stock

We released 119,300 Dworshak-stock summer steelhead from the south pond directly into Hayden Creek on 21 April 1978. Samples consisting of 1,101 fish from the early, middle and late segments of the release showed an average length of 166.4 mm (6.6 in) and 22.6/kg (10.3/lb) (Fig. 4). We observed a wide range of lengths 85-225 mm (3.3-8.9 **in)** and a large number of sub-smolts (38.7%). The fish over 160 mm (6.3 in) were classified as very good smolts showing the expected physical characteristics. Some fish as small as 140 mm (5.5 in) showed signs of smoltification.. Seaward emigration appeared good evidenced by few (±2%) of the released fish remaining near the hatchery after 4 days. Moderate dorsal deformity was observed on most of the fish in this group.

Comparison of Releases

At the time of release the two groups were nearly equal in length (north pond - 164.6 mm vs. south pond - 166.4 mm) but the north pond fish weighed slightly more, 21.5/kg opposed to 22.6/kg. This was likely due to the larger number of sub-smolts among the Skamania fish in the north pond that didn't show the slimness accompanying smoltification.

The percent of smolt-size fish was higher for the Dworshak fish (62.3%) than the Skamania fish (52.8%). The modal length for both groups was 185 mm (7.3 in). We observed more large smolts, 185-245 mm (7.3-9.6 in) among the Skamania fish.

Sympatric Rearing - Summer Steelhead vs. Spring Chinook Salmon

Incubation

We confirmed that by using the eggs from late spawning spring chinook salmon from the Rapid River Hatchery and eggs from the very early spawning steelhead which returned to the Skamania Hatchery, we could synchronize the time of button-up to within a few days. This was accomplished by controlling the proportions of Hayden Creek water 1-9 C (34-48 F) and spring water 12.0 C (53.6 F) used for incubation, thereby controlling the rates of development.

Raceway Rearing

We determined that we could equalize the size of the two groups of fry by the time of ponding in mid-July although the steelhead were 6,050/kg (2,750/lb) at button-up when they were moved to the raceway and the chinook were 3,168/kg (1,440/lb) at this time. This too was accomplished by controlling the proportions of Hayden Creek and spring waters used for rearing.

Pond Rearing

Although pond rearing is incomplete at the time of writing (November 1978) we have made some preliminary observations. We looked at competition by noting behavior and growth of the two species.

Segregation started within the first week of pond rearing and has continued in varying degree until the present. The chinook stayed in schools located under the feeder platforms and near aquatic vegetation at the edge of the pond. The steelhead were primarily located in mid-pond positions and in more dispersed

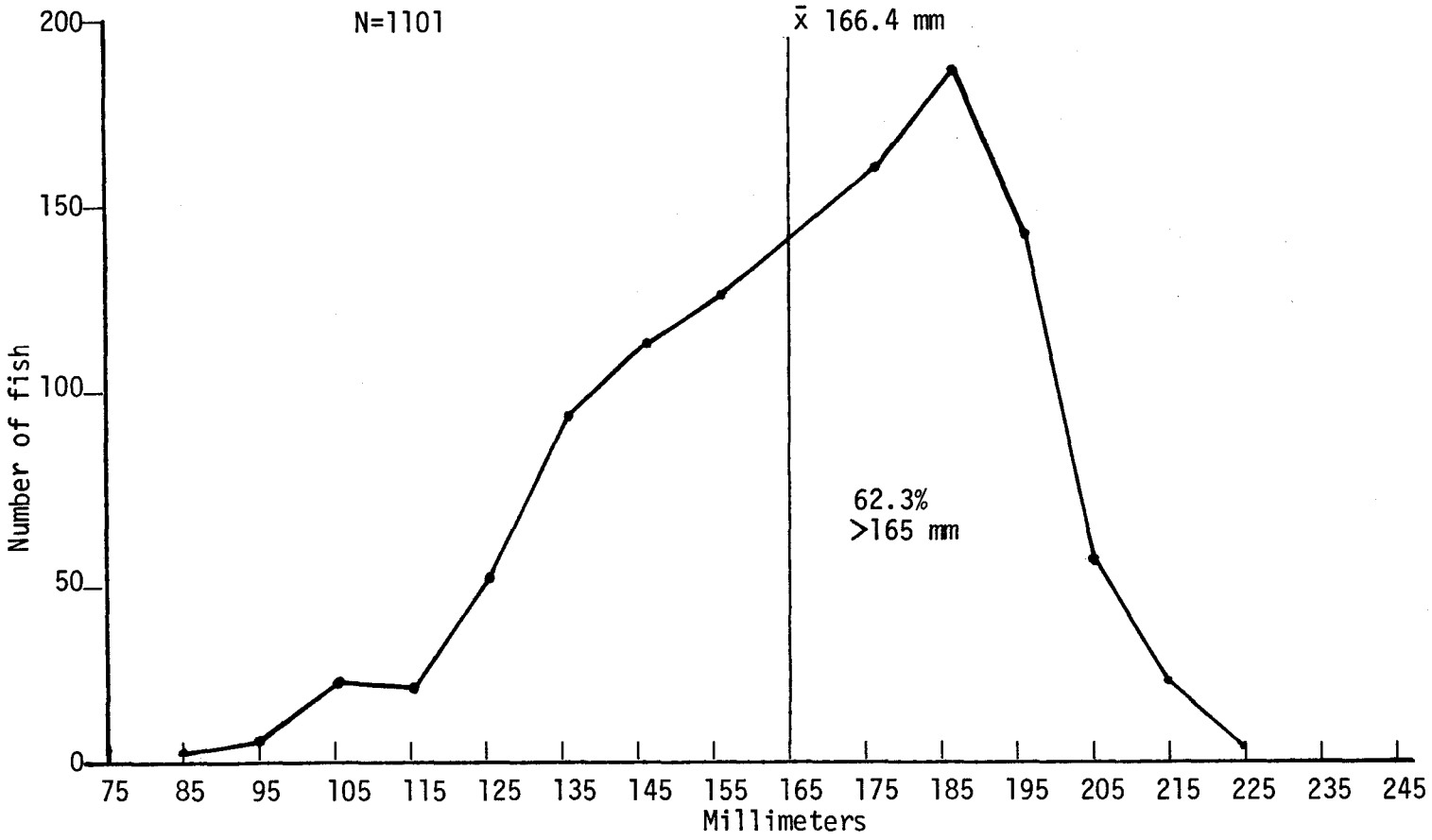

Figure 4. Length frequency of Dworshak stock steelhead trout released from the Hayden Creek south pond, 20 April 1978.

groups than the chinook. The steelhead were predominate at the pond's inlet with a few of the larger chinook intermingled. More steelhead were observed in the upper one-half of the pond and more chinook in the lower one-half. The distribution changed during feeding periods. During the first few seconds after the broadcast feeders activated, chinook occupied most of the feeding positions but the steelhead became increasingly prevalent. The chinook were congregated at the innermost feeding positions by the end of the feeding period (2-3 min) and the steelhead held positions at the perimeter of the feed distribution area. The net result was that the steelhead occupied an estimated 70% of the feeding area. Net sampling supported this observation. We found that if the umbrella net was raised shortly after baiting with feed that we captured more chinook than steelhead (60:40). If the net was left down for one minute or longer we captured about 80% steelhead. We feel these observations can be explained by the chinook occupying positions near the feeders during nonfeeding periods and being displaced by the dominant steelhead when the competition for food breaks down the nonfeeding distribution.

Growth was greater for the steelhead than the chinook, and also greater for the allopatric chinook (north pond) than the sympatric chinook (south pond). In the 30 October 1978 sample, the steelhead averaged131.8 mm (5.2 in) while the sympatric chinook averaged104.4 mm (4.1 in). Although the allopatric chinook were slightly smaller at ponding, we calculated a 12.5 mm (.5 in) or a 9% greater length increase for these chinook than the chinook rearing with the steelhead in the south pond. We believe this reflects the competition occurring among the steelhead and chinook rearing together in the south pond.

Rearing - Release of Age I Spring Chinook Salmon

Age I - Spring (1978) Release

As part of the 1976-77 chinook rearing program at the Hayden Creek Research Station an Age 0-Age I smolt release comparison experiment was initiated (Anderson - 1978).

Prior to the 8 October 1977 release of 75,500 Hayden Creek/Rapid River-stock chinook smolts, we transferred 18,400 fish to the north raceway for overwinter rearing and eventual comparison with the Age 0 fall release. We held the fish in a predominately Hayden Creek water mix 2-9 C (34-48 F) and hand fed dry diet four times per day. One medicated feed treatment of Oregon Moist Pellets (OMP) laced with Erythromycin prevented bacterial kidney disease (KD) which caused 50% mortality in a similar group in 1975-76.

On 22-23 March 1978 we coded wire tagged and adipose clipped 15,300 of these Age I+ spring chinook smolts. We released them into Hayden Creek via the spring bypass. These fish average 187.4 mm (7.4 in) and 14.1/kg (6.4/lb) (Fig. 5). We checked 529 fish for tag retention on 30 March 1978 and found three without tags for a retention rate of 99.4%. The fish migrated from the hatchery area during the first night after release.

Adult Returns - 1978 Spring

Chinook Salmon

A total of 106 adult spring chinook salmon returned to the Hayden Creek

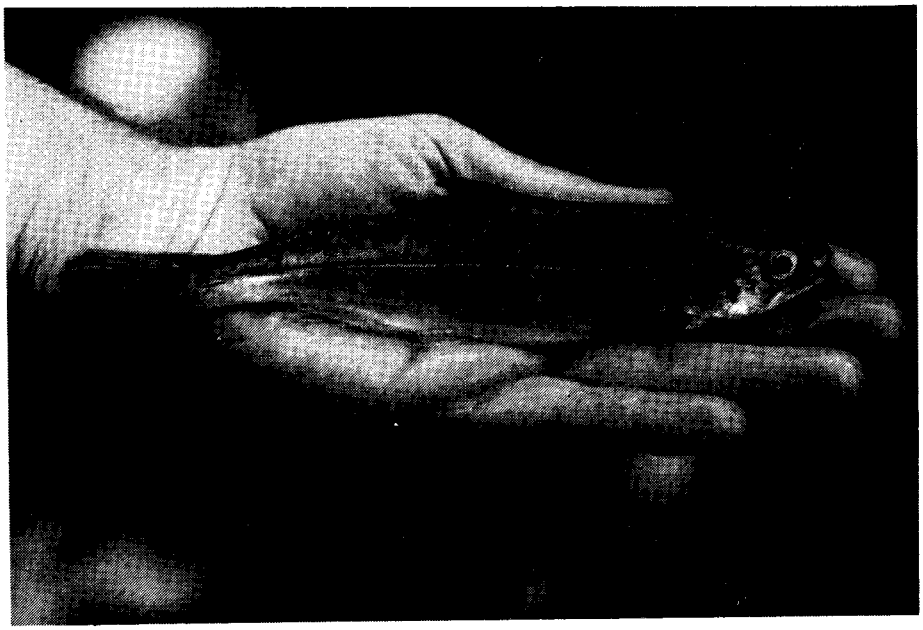

Figure 5. The Age I spring chinook released in March 1978 averaged 187.4 mm (7.4 in) fork length and 14.1/kg (6.4/lb).

Table 3. Summary of spring chinook smolt releases and adult returns to Hayden Creek Research Station since 1971.

Brood year	Year released	Number juveniles released	Number marked	Mark used	Number adults returned as: River race	One-ocean fish	Two-ocean fish	Three-fish
1971	1972 (Oct.)	312,000	73,000	RV, L Max	Rapid River	38 (1974)	120 (1975)	10 (1975)
1972	1973 (Oct.)	151,000	0	--	Rapid River	27 (1975)	8 9 (1976)	4 (1977)
1973	1974 (Sept.)	350,000	0	--	Rapid River	9 (1976)	45 (1977)	13 (1978)
1974	1975 (Oct.)	276,000	0	--	Rapid River	5 (1977)	74 (1978)	_ (1979)
1974	1976 (April)	6,000	0	R Max	Rapid River	0 (1977)	0 (1978)	_ (1979)
1975	1976 (Sept.)	255,000	0	--	Hayden Creek- Rapid River Mix	19 (1978)	_ (1979)	_ (1980)
1976	1977 (April)	99,000	9,600	AD-CWT	Rapid River	(1978)	_ (1979)	(1980)
1976	1977 (Sept.)	86,000	86,000	AD-CWT	Hayden Creek- Rapid River Mix	_ (1979)	_ (1980)	_ (1981)
1976	1977 (Oct.)	75,500	0	--	Hayden Creek- Rapid River Mix	(1979)	_ (1980)	_ (1981)
1976	1978 (April)	15,300	15,300	AD-CWT	Rapid River	_ (1979)	(1980)	(1981)

Table 4. Summary of steelhead smolt releases and adult returns to Hayden Creek Research Station since 1970.

Brood year	Year released	Number juveniles release	marked	Mark used	River race	Number adults returned as: One-ocean fish	Two-ocean fish
1970	1971 (May)	72,000	38,000	LV	Lemhi Weir, 1970 return	5 (1973)	17 (1974)
1970	1972 (March)	87,500	50,000	LV	Lemhi Weir, 1970 return	3 (1974)	2 (1975)
1971	1973 (April)	31,700	13,800	LV	Lemhi Weir, 1971 return	2 (1975)	23 (1976)
1972	1973 (Nov.)	47,000	0	--	Lemhi Weir, 1972 return	21 (1976)	18 (1977)
1973	1974 (April)	80,000	0	--	Clearwater		
1973	1975 (April)	229,000	0	--	Clearwater Hayden Creek	6 (1977)	20 (1978)
1975	1976 (April)	125,000	0	--	Washougal	0 (1978)	__ (1979)
1976	1977 (April)	100,000	100,000	CWT & AD	Washougal	--(1979)	__ (1980)
1976	1977 (April)	99,000	0	--	Washougal	__ (1979)	__ (1980)
1977	1978 (April)	117,500	0	--	Washougal	__ (1980)	__ (1981)
1977	1978 (April	lla 3n	0	--	Clearwater	__(1980)	__(1981

trap from 1 June to 23 August 1978. We classified 19 adults as 1-ocean, 48.3-61.0 cm (19-24 in); 74 as 2-ocean, 61.0-83.3 cm (24-33 in) for females and 61.0-88.9 cm (24-35 in) for males; and 13 as 3-ocean returnees > 83.8 cm (33 in) for females and > 88.9 cm (35 in) for males (Table 3). We innoculated the 2-ocean and 3-ocean adults with an Erythromycin phosphate stock solution administered by subcutaneous injection near the origin of the dorsal fin at a dosage level of .1 cc/lb of fish weight as a treatment for Kidney Disease. One 2-ocean female had a left ventral fin clip of unknown origin, no other marked adults were noted. Approximately 10% of all returnees showed nitrogen scars and five adults showed apparent gill net scars. We released the 1-ocean adults (jacks) in the Lemhi River near Tendoy on 22 July 1978.

On the night of 4 July, four females were stolen from the holding pens. The next day we transferred all the adults to the large holding pond to prevent more theft. During pond retention six females died of fungus covering the head and gills (secondary infection to nitrogen scars).

On 31 July 1978 a crew of Fish & Game Department and University of Idaho personnel seined the adult holding pond and transferred the adults to the holding pens for sorting and checking for ripeness. The operation proved lethal to nine females and four males. We suspect the cause of death was stress and very turbid water. Autopies on the 13 dead fish revealed two with bacterial kidney disease. We will no longer hold adults in the holding pond. We released 52 adults into Hayden Creek on 2 August 1978. These fish carried a left and right opercle punch. Five females and six males were retained for use by the University of Idaho.

Spawning ground surveys were conducted on Hayden Creek and its major tributary, Bear Valley Creek, to estimate the number of adults that bypassed the trap and spawned naturally in these streams. We counted 106 redds and estimated that 158 adults bypassed the station. We substracted 27 redds from the 106 count to compensate for the 27 females and 25 males released from the holding pens in early August. Using the number of adults captured at the Hayden Creek trap and the estimated bypass calculated by year-class, we computed a return of 235 adults from the 1974 release of 350,000 smolts. This yields an estimated .067% return rate. This was approximately one-half of the 1973 release return percentage of .140. Both return percentages should be considered minimum values because we did not survey the entire length of Hayden Creek or Bear Valley Creek available to the adults.

Steelhead Trout

Twenty adult summer steelhead returned to the Hayden Creek trap from 3 April to 19 April 1978. All 20 were classified as 2-ocean returnees with total lengths between 71.1 and 86.4 cm (28-34 in) (Table 4). Deformed dorsal fins were observed on two fish. One adult carried a National Marine Fishery Service jaw tag number 4955. No other marks were observed.

We calculated a release-to-return percentage of .012% for the April 1975 release of 229,000 fish. This included 1-ocean returnees in 1977 and 2-ocean adults in 1978 (Table 4). Adults bypassing the hatchery trap and spawning naturally in Hayden Creek was confirmed this year. Later than normal runoff allowed a survey of approximately 3.2 km(2 mi) of the stream above the hatchery. We observed 31 redds in this section. Since surveys were not conducted in previous years we cannot estimate actual numbers of adults which failed to enter the trap,

but this redd count indicated bypass to be considerable, at least 3:1 in the relatively short section surveyed.

The absence of 1-ocean returnees suggests poor survival of the April 1976 release of 125,000 Washougal-stock (Skamania-stock) steelhead, but many factors confound this assumption. This stock of steelhead normally returns as 2-ocean adults, also we do not know the frequency of straying. The 1979 returns will be necessary for further evaluation.

DISCUSSION

Since the initiation of the Hayden Creek Research Station, the basic goal of the station has been to explore the efficacy of rearing steelhead trout to the smolt stage in dirt bottomed ponds. Experiments were conducted involving varying water temperature regimes, feed types and feeding regimes, time of release, handling procedures and genetic stocks, etc.

The results of these research experiments have shown that pond rearing of steelhead smolts is feasible and can produce a good quality steelhead smolt. While adult returns to Hayden Creek have been low, we feel this is not an accurate reflection of the number and quality of the smolts released. Inadequate return facilities; small attraction flow, poor channel and trap location and the lack of a velocity barrier or weir, result in returning adults bypassing the station and spawning in the Hayden Creek system above the hatchery. This factor is known to be considerable (at least three out of four fish in 1978).

Another factor, now making itself known at Hayden Creek and other stations in the upper Salmon River system, is the apparent low return success of downriver stocks; fish used almost exclusively at Hayden Creek for the last few years. The next few years should clarify this phenomenon as adult returns complete the cycle.

During the steelhead rearing history of the station, chinook salmon were also pond-reared as a secondary species, "squeezed in" when facilities did not contain steelhead trout, and released at less than optimum times to facilitate the needs of steelhead. As we became more familiar with the fish cultural needs of the chinook it became apparent that the facilities of the Hayden Creek station were more suitable for the rearing of that species than steelhead trout, and that chinook salmon did extremely well during the entire rearing cycle at the station.

We now feel that the time, need and stage of fish cultural knowledge at the station would best lend itself to placing emphasis on rearing chinook salmon and that this would also best fit in with the general anadromous fish program in the state of Idaho.

We recommend that commencing with the 1979-80 rearing program, we no longer rear steelhead trout and commence a program of research and culture of spring chinook salmon at the Hayden Creek Research Station.

LITERATURE CITED

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